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FURTHER BIRD REMAINS FROM THE SAN DIEGO PLIOCENE

By Loye Miller[1] and Robert I. Bowman[2]

The final presswork on a paper by the senior author (1956) concerning San Diego Pliocene birds had not been accomplished before a further assemblage of material from the same formation came to hand. Part of this material (14 specimens) came from Mr. Joseph Arndt and was deposited in the University of California Museum of Palaeontology, referred to below as U.C.M.P. A larger number of specimens was sent from the Los Angeles County Museum by its Chief Curator of Science, Dr. Hildegarde Howard, with the request to include them in our study. This loaned material will be referred to as L.A.M. Our thanks are extended to Dr. Howard and Mr. Arndt for their much appreciated courtesies. We are further indebted to Dr. Howard for helpful suggestions during the course of our labors.

Specimens assigned to the genus *Mancalla* are not included in this study because no significant additions to our knowledge of that genus have developed since it was reported upon by Miller and Howard (1949). Most of the other specimens are assignable to species recorded by Howard (1949), Brodkorb (1953), or Miller (1956), but it has appeared advisable to describe three species as new to science. The new material relating to previously known species is discussed here because of the additional light it throws upon the forms that were but sparsely represented heretofore.

There is, of course, no anatomical association of skeletal elements in the matrix. Hence the assignment of a bone to a species based upon a type that represents a different element has to be supported by one or more of three factors: first, their occurrence in a fairly restricted geologic formation; second, their relative size as compared with the nearest previously known form; and third, the degree of morphologic divergence from that form. It is freely confessed that there are weaknesses in such procedure and that a large element of personal judgment is involved, but we have endeavored to be conservative in such assignments.

For a discussion of age, matrix, and the ecologic picture of the San Diego Pliocene the reader is referred to the papers by Miller and Howard (1949), Howard (1949), and Miller (1956).

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GAVIIFORMES

GAVIIDAE. LOONS.

Gavia howardae Brodkorb. Specimens of loon from the San Diego beds were tentatively referred by Howard (1949:186-188) to Wetmore's Pliocene species, *Gavia concinna* from Monterey County, California. A later study of all the known Pliocene loons by Brodkorb (1953) led to his establishment of the species *Gavia howardae* for part of the San Diego material (3 humeri), and the definite assignment of the remainder (upper and lower mandibles, cranium, and additional humeri) to *Gavia concinna.* Since then Miller (1956:617) has assigned an incomplete tibiotarsus to *G. howardae* and an incomplete humerus to *G. concinna.*

On the basis of the humerus, Brodkorb states that *Gavia howardae* is slightly smaller than *Gavia arctica pacifica* or *G. stellata,* whereas *Gavia concinna* exceeds in size these two Recent species. We now have at hand a well-preserved specimen of the distal condyles of the tibiotarsus of a loon (L.A.M. no. 2314) which, on the basis of small size, we assign to the species *G. howardae.* The fossil differs from *G. a. pacifica* as follows: the condyles, though only slightly worn, are each thinner in the transverse diameter, giving the impression that they must have articulated with smaller tarsal cotylae that were separated by a relatively broad intercotylar tuberosity; the supratendinal bridge is more nearly at right angles to the shaft, is more nearly uniform in width, and the proximal opening of the tendinal canal is almost perfectly circular; the distal orifice of this canal is more slit-like (Fig. 1).

No further material representing the loons has come to light.

COLYMBIFORMES

COLYMBIDAE. GREBES.

Colymbus parvus Shufeldt. A total of 45 bones (38 L.A.M. and 7 U.C.M.P.) representing nine skeletal elements, forms the basis of this review. These include the following: femur 4, tibiotarsus 9, tarsometatarsus 15, humerus 7, radius 2, ulna 3, carpometacarpus 3, scapula 1, and coracoid 1. Three of these elements, namely the femur (L.A.M. nos. 2189, 2203, 2569; U.C.M.P. no. 45881), radius (L.A.M. no. 2563; U.C.M.P. no. 45893), and scapula (L.A.M. no. 2523) heretofore have been unknown for *Colymbus parvus.* These bones are not lacking in diagnostic features that unquestionably ally them with *Colymbus.* Nevertheless, they are smaller than *C. grisigena,* yet larger than *C. auritus,* thus bearing the same size relationship to these species as do the other known elements of *C. parvus.*

The excellent preservation of several of the bones permits the taking of certain measurements (see Table I).

TABLE I

Measurements of bones of *Colymbus parvus*, in millimeters

FEMUR

(All dimensions are maximum, except as indicated)

	Length	Breadth proximal end	Breadth distal end	Breadth across fibular & external condyles	Depth external condyle	Minimum diameter of shaft
L.A.M. 2189	42.15	12.00	12.60	5.57	9.10	4.70
L.A.M. 2203	.....	.....	.....	5.57	.....	.....
L.A.M. 2569	.....	11.45	.....	.....	.....	.....
U.C.M.P. 45881	.....	.....	12.00	.....	.....	.....

RADIUS

	Minimum diameter of shaft	Maximum diameter of shaft
U.C.M.P. 45893	2.00	4.20

SCAPULA

	Length of head from anterior tip of furcular articulation to posterior edge of glenoid facet
L.A.M. 2523	8.35

CORACOID

	Maximum length on lateral edge	Maximum length on medial edge	Breadth of base from sternocoracoidal process to int. distal angle	Maximum antero-posterior diameter brachial tuberosity	Mimimum diameter of shaft
U.C.M.P. 45873	40.70	38.40	12.70	6.70	3.35

Colymbus parvus has been carried back in time from Pleistocene (Shufeldt, 1913), through upper Pliocene (Wetmore, 1937), to lower middle Pliocene (Howard, 1949). Its known geographic distribution is from southern Oregon to southern California. Only in San Diego do we find it in deposits of salt water origin. Furthermore, in comparison with numbers of associated bird species, it reaches maximum abundance in the San Diego formation. It is perhaps significant that among 2500 bird bones from the Pleistocene of Oregon, there are only 11 bones of this grebe, whereas among 500-600 bones from the San Diego Pliocene, there have now been determined no less than 58 of this species. The species is unrecorded from the Pleistocene of California.

The presence of a small grebe in the Pliocene formation of San Diego was first reported by Howard (1949:185) who described, but left unnamed, the femur (L.A.M. no. 2118) and the tibiotarsus (L.A.M. no. 2129) "of a grebe smaller than *Colymbus parvus*." Also, the senior author (Miller, 1956:617) noted "some imperfect bones of a small grebe" from the same formation although the particular elements were not designated. Additional material is now available, and it is evident that a new species of grebe should be named. It is, therefore, described as follows:

Colymbus subparvus, new species. Fig. 5

Type. — L.A.M. no. 2568, a right femur lacking proximal end and small areas of distal end. L.A.M. loc. 1080, Washington Blvd. freeway, south of University Ave., San Diego; Pliocene. Collected by T. Downs, 1952.

Diagnosis. — Distal end approximately the same size as in *Podilymbus podiceps* (Mus. Vert. Zool. no. 118985) and from 8 to 13 per cent narrower than in *Colymbus parvus* (see Table II). Profile of rotular grove (frontal aspect) with much more steeply inclined lateral wall than in *C. parvus*. Remainder of description as in Howard (1949:185) for specimen L.A.M. no. 2118: "fibular condyle deeper, and junction of its proximal border with the external intermuscular line more anterior in position; . . . less constriction of shaft internally, above internal condyle." See Fig. 5.

Paratype. — L.A.M. no. 2118, left femur, lacking proximal end and adjacent shaft, with condyles heavily eroded. L.A.M. loc. no. 1071, Curlew St. near Ostego Drive, San Diego; Pliocene. Collected by G. P. Kanakoff, 1947.

Referred material. — L.A.M. no. 2129, proximal head of left tibiotarsus with approximately 15 mm. of adjacent shaft; lacking all of internal and most of external cnemial crest, with edges heavily eroded. L.A.M. loc. no. 1080; collected by G. P. Kanakoff, 1947. L.A.M. no. 2354, left coracoid, complete except for minor areas which are eroded. L.A.M. loc. no. 1079, canyon east of Balboa Park, San Diego. Collected by Clifford Kennell, 1950.

The tibiotarsus is closest to *Colymbus* in degree of distal extension of the external cnemial crest along the anterior surface of the shaft. Its size is approximately as in *Podilymbus podiceps*. It also resembles this species in the "flare of the external crest" (Howard, loc. cit.), but otherwise shows a distinctive configuration. Although the coracoid gives a superficial appearance of immaturity, due to heavy erosion, details of muscle scars are so clearly defined that we may assume the

bone came from an adult or nearly adult bird. It is referred to *Colymbus* on the basis of general configuration and to *C. subparvus* on the basis of size.

Grebe, species undetermined. A well preserved distal half of a very small, grebe femur (L.A.M. no. 2605) resembles that of *C. subparvus* in the steeply inclined lateral wall of the rotular groove seen in frontal aspect. In distal breadth, however, it measures only 8.0 mm. (28 per cent smaller than the type of *C. subparvus*). Compared with Recent grebes, the bone is remarkably similar in size to a specimen of *C. occidentalis* (M.V.Z. no. 125154) from Peru, hence smaller than in *C. auritus*. Other characters, however, are in general similar to those displayed by specimens of Recent Eared Grebes.

Although femur L.A.M. no. 2605 appears to be distinct from specimens of this element known for other fossil or Recent grebes, we prefer to refrain from establishing a new species on the basis of this single bone.

TABLE II

Measurements of bones of *Colymbus subparvus*, in millimeters
(Per cent smaller than *C. parvus* shown in parentheses)

FEMUR*

	Maximum breadth distal end	Breadth across fibular and external condyles	Maximum depth external condyle	Minimum diameter of shaft
L.A.M. 2568	11.0 (8-13)	4.9 (12)	7.7 (15)	4.2 (11)
L.A.M. 2118	.....	5.0 (10)	.....	4.1 (13)

TIBIOTARSUS

	Minimum diameter of shaft approx. 15 mm. from base of proximal head
L.A.M. 2129	3.4 (23 +)**

CORACOID*

	Maximum length on lateral edge	Maximum anteroposterior diameter of brachial tuberosity	Minimum diameter of shaft
L.A.M. 2354	37.70 (7)	5.90 (12)	3.15 (6)

*For comparable measurements of *C. parvus*, see Table I.
**This percentage may be inaccurate (too small) as the comparable measurement on *C. parvus* (tibiotarsus U.C.M.P. no. 45876) of 4.4 mm. may be influenced by erosion of the bone.

PROCELLARIIFORMES

PROCELLARIIDAE. SHEARWATERS.

Puffinus kanakoffi Howard. This species was described (Howard, 1949:187) as a "small shearwater similar in size to *Puffinus opisthomelas*" but with certain osteologic characters that distinguish it from that species. The tarsometatarsus, humerus, and femur, were discussed. Miller (1956:617) added a few items concerning the humerus, stating that a specimen in the U.C.M.P. collection was shorter but actually heavier in shaft and condyles than in Recent *P. opisthomelas*.

We now have before us parts of nine fossil humeri (7 L.A.M. and 2 U.C.M.P.), three tarsometatarsi (1 L.A.M., 2 U.C.M.P.) and a vertebra (U.C.M.P.) that we consider to be of the one species, *P. kanakoffi*. The lengths are not accurately measurable on all of the specimens of humeri and tarsometatarsi but they appear not to vary too greatly for inclusion in one species. There is an appreciable variation in width of shaft in the humeri that we would ascribe to age of the individual, since one specimen strongly suggests an immature bird. The following measurements were taken on complete or nearly complete specimens: humerus, L.A.M. no. 2516, length 85.0 mm.; U.C.M.P. no. 45896, length 91.2 mm., greatest breadth across distal condyles, 11.4 mm.; tarsometatarsus, L.A.M. no. 2572, length 45.5 mm., breadth of distal end 6.3 mm.

While we may not be able to add appreciably to the osteologic picture of *P. kanakoffi*, we may perhaps sharpen the focus on the ecologic picture. Miller and Howard (1949) visualized the San Diego accumulation as that of a tidal flat with small islets fairly nearby, thus furnishing for *Mancalla* a loafing and sunning ground with insular breeding sites close at hand. The fairly abundant remains of the Kanakoff Shearwater (a total of 27 specimens now recorded), would tend to accentuate this impression. Though shearwaters today do not congregate on sand bars to rest, they are highly gregarious birds both during the nesting season and the remainder of the year. Epidemics or other adverse factors often cause great mortality, and on occasion their bodies are cast up on the sands in great numbers. The islets that afforded nesting grounds for *Mancalla* might likewise have accommodated the shearwaters or even the aberrant barn owl, *Lechusa stirtoni*, if rocky cliffs were exposed in places.

PELECANIFORMES

SULIDAE. BOOBIES.

The only sulid previously reported from the Pliocene of the west

coast is *Miosula recentior* Howard (1949:190) from the San Diego deposits. A large tibiotarsus and a small ulna were assigned as type and cotype respectively and a fragment of a small humerus tentatively referred. The three specimens were not associated in the matrix. The assignment was rationalized on the basis that *Miosula* (Miller, 1925: 115) was described as a form with stout legs and weakened wings, thus suggesting a modification toward the cormorants, with greater swimming power than is possessed by *Sula.*

We now find in the San Diego formation the distal third of a sulid humerus and a femur which is complete except for the inner condyle. The humerus is larger than in *Sula sula websteri* or *S. leucogaster brewsteri,* though smaller than in *Morus bassanus.* It is distinguished from the genus *Miosula,* as represented by *Miosula media* Miller from the Lompoc Miocene, by lesser curvature of the shaft. In general characters it resembles the humerus as found in the genus *Sula.* The femur is smaller than that of *Sula dactylatra,* but exceeds that of *Sula sula* in about the same proportion as does the humerus. It is far too small, however, to have articulated with the gigantic tibiotarsus of *Miosula recentior,* described by Howard (1949:190) as "larger than in any living member of the family." The humerus and femur, therefore, are believed to represent a species new to science.

Sula humeralis, new species. Fig. 2

Type. — U.C.M.P. no. 45889, distal third of right humerus, practically unworn and apparently representing a fully mature bird. San Diego; Pliocene. Collected by Joseph Arndt.

Diagnosis. — Shaft heavy and less curved than in *Miosula;* ectepicondyle and entepicondyle less prolonged up the shaft than in living sulids but both epicondyles broadened; ulnar condyle relatively large; internal tricipital groove relatively shallow as compared with *Sula leucogaster.* See Fig. 2.

Detailed description. — The type humerus is larger than available specimens of either *Sula sula websteri* or *S. leucogaster brewsteri,* but markedly smaller than *Morus bassanus,* and with characters more closely related to *Sula.* Characters of the palmar aspect ally it with *S. leucogaster* rather than with *S. dactylatra* or *S. sula;* the impression of brachialis anticus is defined distally by a transverse ridge as in *S. leucogaster* (this ridge is lacking or only faintly indicated in *S. dactylatra, S. sula,* and *Morus bassanus);* distal to this ridge, the brachial depression is almost triangular in outline with (1) its broad base lying transversely under the overhang of the internal (ulnar) condyle, (2) its external side defined by a ridge extending obliquely inward from the

external condyle, and (3) its internal side defined by the entepicondylar prominence. This triangle is not as nearly perfect in any living species of sulid examined but is approached in *S. leucogaster* and is remote from *S. dactylatra.* The area is more depressed than in *Morus bassanus.* The interior border of the brachialis depression forms a pronounced ridge broadening distally into a fairly heavy mass of bone; this broadened area is less in *S. leucogaster* and *S. sula* and least in *S. nebouxi.* The entepicondylar area is less pronounced than in any available living sulid; the area is most prominent in *S. sula* and is intermediate in *S. nebouxi* and *S. leucogaster.* The ligamental attachments at the entepicondyle and ectepicondyle are shorter and broader than in living sulids, except *S. dactylatra.*

When the bone is viewed from the distal end in line with the axis of the shaft, the ulnar condyle is relatively larger in comparison to the radial condyle than in *S. sula, S. nebouxi,* or *S. leucogaster,* but the mesial ridge defining the tricipital groove is less developed; the external tricipital groove, therefore, appears to lie more toward the sagittal line and less toward the lateral border; the outer ridge of the tricipital groove is well developed. The shaft is heavy, its diameter relative to the expanded articular end is greater than in specimens of living species at hand, approaching *S. nebouxi* most nearly. The curvature of the shaft is similar to living species of *Sula* and is straighter than in *Miosula.*

Measurements of type. — Maximum width across distal end, 19.8 mm.; minimum diameter of shaft, 8.0 mm.; ratio of shaft to distal end, .40.

Referred material. — L.A.M. no. 2522, femur complete except for inner condyle. L.A.M. loc. 1128, Washington St. between 1400 block and Highway 395, San Diego; Pliocene; collected by Clifford Kennell, 1954. An eroded fragment of sulid coracoid, L.A.M. no. 2521, may possibly represent this species; locality, collector and date as for the femur.

In the femur, the fracture that deprived us of the inner condyle involved also the contour between the condyles and the popliteal area. So far as preserved, its characters are as follows: it is longer than in *Sula sula websteri,* but the shaft is more slender and the contours are more rugged. The effect is of a strongly activated bone despite its slenderness. Recent sulids examined give the impression of weakness in the femur. Measurements: length along external side, 58.2 mm.; minimum breadth of shaft, 5.5 mm.; breadth of proximal end, 13.2 mm.

Discussion. — *Sula humeralis* is distinguishable from fossil sulids of

other California localities as follows: from *Morus vagabundus* Wetmore, *Morus lompocana* Miller, and *Morus reyana* Howard, it is distinguished by the fact that its characters are distinctly those of *Sula* rather than *Morus*. From *Sula stocktoni* Miller it is distinguished by smaller size, and from *Sula willetti* by markedly larger size. Compared with *S. willetti*, also, the femur of *Sula humeralis* is not only longer, but its distal end is more expanded.

With the establishing of this second sulid species from the San Diego formation, the femur of which is markedly smaller and more slender than could be expected for articulation with the tibiotarsus that forms the type of *Miosula recentior*, it seems proper to raise the question of the allocation of the ulna that forms the cotype of the latter species.

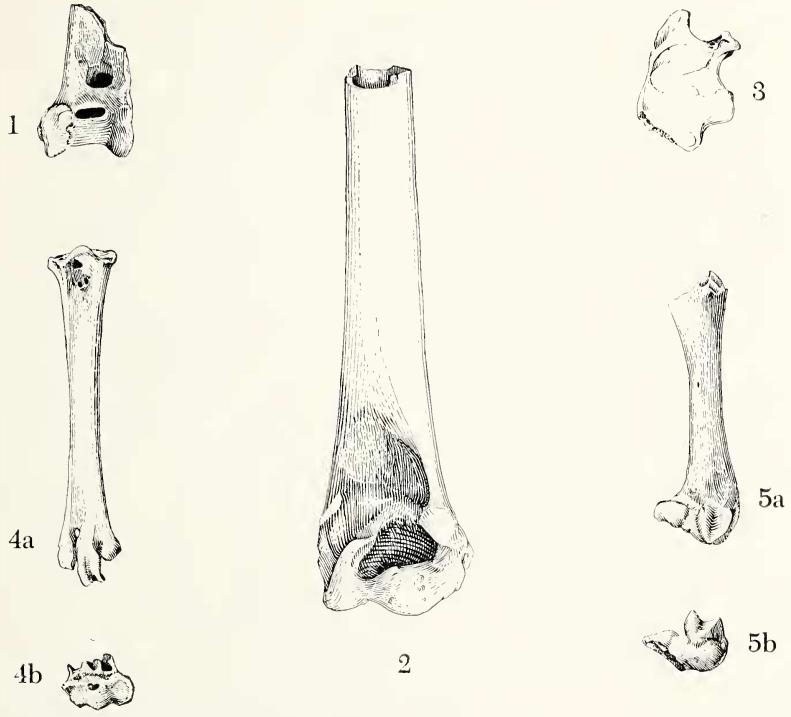

Fig. 1. *Gavia howardae*. Tibiotarsal condyles, L.A.M. no. 2314. Natural size. Fig. 2. *Sula humeralis*, new species. Type specimen. Distal end of humerus, U.C.M.P. no. 45889. Natural size. Fig. 3. *Phalacrocorax kennelli*. Head of tibiotarsus, L.A.M. no. 2566. Natural size. Fig. 4. *Ptychoramphus tenuis*, new species. Type specimen. Tarsometatarsus, U.C.M.P. no. 45662. *a*. Anterior face. x 2. *b*. Proximal end. x 2. Fig. 5. *Colymbus subparvus*, new species. Type specimen. Femur, L.A.M. no. 2568. *a*. Anterior face. Natural size. *b*. Distal end. Natural size. All drawings by Gene M. Christman.

Unfortunately there is no anatomical association in the specimens from the San Diego Pliocene. The sulid species from the Lompoc and Lomita Miocene deposits of California are based on articulated skeletons that show the size ratios of various segments in the skeleton. Although this is not the case for the San Diego fossils, the relative size of the sulid humerus, ulna, and femur, as compared with living species, supports the conclusion that they could all represent one form. The large tibiotarsus of *Miosula recentior* appears to stand apart. After weighing the problem carefully, therefore, we recommend that the ulna (L.A.M. no. 2112) be reclassified as *Sula humeralis.*

PHALACROCORACIDAE. CORMORANTS.

Phalacrocorax kennelli Howard. For the present study we have additional cormorant material representing the tibiotarsus (L.A.M. no. 2566), femur (L.A.M. no. 2528), ulna (L.A.M. no. 2529), and coracoid (L.A.M. no. 2282) all of which harmonize fairly well with Howard's (1949:188) concept of the species, namely, a small cormorant intermediate in size between *Phalacrocorax auritus* and *P. pelagicus.*

L.A.M. no. 2566 is a complete right tibiotarsus in almost as perfect condition as a well-preserved Recent bone. Only the varied dark coloring makes it slightly less easy to study. The total length (100 mm. to the proximal articular surface) is just equal to that of a specimen of a male *P. pelagicus* from Alaska; the fossil is, however, definitely stouter and more curved towards the median plane. The curvature is perhaps correlated with the fact that the outer condyle is less extended distally, i.e. it is raised above the level of the inner condyle. The notch between the condyles is shallower and more open. When viewed from the side, the contours of both the condyles form a more nearly circular arc and are more evenly curved in outline. The fibular crest is less developed along the area of contact proximally as well as at the distal point of fusion of fibula, tibia, and proximal tarsals. When the bone is viewed from the proximal end, the pattern is quite different from that seen in *P. pelagicus* (Fig. 3). The outer cnemial crest is much less developed, whereas the inner crest is powerful and is bent over towards the external side leaving a narrower notch between crests. The condition is somewhat similar to that seen in *P. auritus,* though different in detail. The external articular surface is broader and rounder and less extended to a point on the external contour. The notch between this contour and the external crest is much more enclosed. We have not seen these characters displayed in any other cormorant examined.

The femur is complete and almost perfect in preservation of details.

In size it is slightly less than a male *P. pelagicus*, but the size difference between Recent specimens of *P. pelagicus* and *P. auritus* is so slight as to fall within the range of a single species. The fossil femur measures 55.5 mm. and is larger than a specimen of female *P. auritus* at hand. Slight osteological differences that appear in comparing the fossil with one Recent specimen fall to the ground when a series of Recent birds is studied. In fact, we find no stable character in the femur that sets the Pliocene bird apart from the Recent smaller cormorants of the California coast.

The ulna measures 141.0 mm. in length and is markedly smaller than available specimens of *P. auritus*, but larger than those of *P. pelagicus*.

The coracoid is represented only by a fragment of the upper end which is devoid of diagnostic characters.

CHARADRIIFORMES

ALCIDAE. MURRELETS AND AUKLETS.

Brachyramphus pliocenus Howard. In the senior author's general paper (1956:618) dealing with the San Diegan fauna, a tarsometatarsus (U.C.M.P. no. 45662) was tentatively assigned to this species. The question was raised, however, as to the generic assignment, as the tarsometatarsus seemed more closely to resemble *Ptychoramphus*. Neither the type humerus nor the cotype ulna of *B. pliocenus* was available for study. Another complete ulna (L.A.M. no. 2573) has now come to hand. It is definitely different from *Ptychoramphus aleuticus* and appears to conform to the characters described for the cotype of *Brachyramphus pliocenus* (Howard, 1949:192) although there is a size difference amounting to more than 10 per cent in length. This discrepancy is not greater, however, than is found to exist in a series of bones of *Pinguinis impennis* from the mounds on Funk Island. We, therefore, see no reason for doubt in assigning these two ulnae to the same species.

The tarsometatarsus in the U.C.M.P. collection is not separable on osteologic characters from *Ptychoramphus*, though it is shorter and more slender than in *P. aleuticus*. It is, however, longer than in *Brachyramphus marmoratus*. Compared with *P. aleuticus*, Recent *B. marmoratus* has considerably shorter leg bones, although the humeri are longer and the ulnae of the two species are of about equal length. *B. marmoratus* has, in fact, a surprisingly weak foot as compared with *P. aleuticus*. The length of the tarsometatarsus in *B. marmoratus* is approximately 45 per cent of that of the ulna, whereas in *P. aleuticus*, it is approximately 65 per cent.

If we were to allocate the fossil tarsometatarsus with the humeri

and ulnae now assigned to *Brachyramphus pliocenus* we would find the species incongruous in either *Brachyramphus* or *Ptychoramphus* as known today. The characters of the wing bones and their relative size bespeak the genus *Brachyramphus,* whereas the characters of the tarsometatarsus are those of *Ptychoramphus.* The ratio of the length of the tarsus relative to length of either ulna now assigned to *B. pliocenus* would be slightly less than in *Ptychoramphus* but far greater than in *Brachyramphus.* We prefer, therefore, to recognize the presence of two genera of small alcids in the San Diego formation, the one represented by wing elements and the other by a single perfect tarsometatarsus. The latter specimen we assign to the genus *Ptychoramphus* and erect for it a species category that is new (see below). Hence, the suggestion offered by the senior author (Miller, 1956:618) regarding the generic reassignment of *Brachyramphus pliocenus* is no longer valid.

Ptychoramphus tenuis, new species. Fig. 4

Type. — U.C.M.P. no. 45662, a perfect right tarsometatarsus; San Diego; Pliocene. Collected by Joseph Arndt.

Diagnosis. — Tarsometatarsus similar to that of *Ptychoramphus aleuticus* (Pallas), but shorter and more slender, and inner condyle more distinct and set off more gradually from middle condyle. See Fig. 4.

Measurements of the type. — Length 21.7 mm.; breadth of proximal end 4.4 mm.; breadth of distal end 4.— mm.; minimum mediolateral diameter of shaft 1.9 mm.; minimum anteroposterior diameter of shaft 1.6 mm.; ratio of minimum mediolateral diameter of shaft to length of tarsometatarsus 8.7 per cent.

Discussion. — The character of the inner condyle of the tarsometatarsus is suggestive of that of *Sterna,* but the bone as a whole is clearly that of an alcid. The shape of the head and excavation of the anterior surface of the shaft closely resemble the contours of *P. aleuticus.* The pattern of the hypotarsal ridges also is most nearly like that of *Ptychoramphus* and is widely different from *Brachyramphus.* There are four well-developed hypotarsal ridges of which the inner one is the strongest. In the Recent *P. aleuticus* there is an enclosed channel or tunnel between this inner ridge and the one next to it; unfortunately it is not quite certain whether or not this channel was enclosed in the fossil, although there is strong indication that it was. This enclosed channel is present in both *Synthliboramphus* and *Aethia,* but the pattern of the ridges is otherwise quite divergent.

SUMMARY

Seventy-three determinable bird bones, and numerous fragments from the San Diego Pliocene have been examined in this study, although *Mancalla*, the most abundant San Diegan form, was not treated further here. Ten species are discussed, of which three, namely, *Sula humeralis*, *Colymbus subparvus*, and *Ptychoramphus tenuis*, are new to science, and new light is thrown on the others. *Colymbus parvus* was found to be second only to *Mancalla* in point of numbers.

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